Effects of Potassium Fertilizers on Sugar Beet Yield and Quality

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Potassium (K) is important to sugar beet yield and quality, in balance with other essential plant nutrients. Two sources of K fertilizer were included in this study.

Sugar beet production is important for edible sugar supply in northern China. The crop is grown on approximately 300,000 ha in Heilongjiang province. Located in the northeastern region of China, the 100 to 140 day frost-free period and large day- and night-time temperature differences make it favorable for sugar beet production.

With K application, sugar beets grew more vigorously.

The crop is a heavy K feeder but the importance of K for improving sugar beet yield and sugar content is still unknown to most growers in the province. The reasons for this relate to (1) limited supply because nearly all K fertilizers are imported, resulting in higher prices, especially for sulphate of potash (K_2SO_4), and (2) many scientists and some farmers have the opinion that chloride (Cl) reduces sugar beet quality. In the final analysis, neither muriate of potash (KCl) nor K_2SO_4 is used. This experiment determined the positive effects of K fertilizers, regardless of source, on sugar beet yield and quality.

The experiment was conducted by pot culture (12 kg air dried soil/treatment) in a screenhouse at the Soil and Fertilizer Institute of Heilongjiang Academy of Agricultural Sciences. The black soil with thin layer used in this experiment is characterized as having 2.9 percent organic matter content and total nitrogen (N), phosphorus (P), and K contents of 0.139, 0.109 and 2.78 percent, respectively. Available N, P and K contents (mg/kg) were determined to be 109.6, 139.0, and 212.0, respectively. Potassium fertilizer was added as either KCl or K_2SO_4 at rates of 50, 100, 150, 200 and 500

Table 1. Effect of K rate and source on sugar beet leaf growth and chlorophyll content.

	Rate, mg K_2O/kg soil	No. of leaves June 23	No. of leaves July 30	Length of leaves, cm June 23	Length of leaves, cm July 30	Chlorophyll content, mg/dm^2 July 5
KCl	50	13.1	27.1	15.2	38.4	7.52
	100	12.5	27.6	14.6	38.9	7.78
	150	14.2	28.9	16.6	39.0	8.41
	200	13.9	26.9	15.3	39.2	6.34
	500	12.3	26.5	14.8	37.7	7.65
K_2SO_4	50	12.4	24.8	14.1	35.8	7.67
	100	13.2	26.7	13.6	36.4	7.75
	150	12.9	25.0	14.9	37.8	7.82
	200	13.5	27.4	15.6	39.1	8.88
	500	13.1	26.3	14.5	38.0	7.70
Ck (NP)		12.8	25.8	13.7	32.6	7.20

mg K_2O/kg soil. Treatment NP was the control (Ck), and rates of N and P fertilizers were equal for each treatment. Where KCl was applied, the N source was ammonium sulphate (12 g/pot) although the soil tested adequate in sulphur (S). The source of P was triple superphosphate (2.6 g/pot).

There was no significant difference between KCl and K_2SO_4 application on sugar beet root yield. Either source increased beet and sugar yield and sugar content.

Effect of Potassium Application on Sugar Beet Growth and Development

Time to seedling emergence as well as its uniformity was consistently good for all treatments, indicating that neither K source had a 'salt' effect on germination.

Data indicate that K fertilizers increase both leaf number and length as well as chlorophyll content compared to the NP control (Table 1). No significant difference between KCl and K_2SO_4 was noted, with the exception that the best application rate for KCl was 150 mg K_2O/kg compared to 200 mg K_2O/kg soil for K_2SO_4. Both sources had a positive effect on sugar beet growth and development.

As a result of improved top growth with the application of K, there was an increase in sugar beet root yield, sugar content, and sugar yield (Table 2). The 150 mg K_2O soil dose from KCl was optimal, increasing sugar beet root yield by 29 percent, sugar content by 2.0 percent and sugar yield by 26.4 percent. Again, the best treatment with K_2SO_4 was 200 mg K_2O/kg soil. In comparison with the control, it increased root yield by 29 percent, sugar content by 0.3 percent and sugar yield by 17.1 percent. However, when considering only sugar content, the best K_2SO_4 treatment was 150 mg K_2O/kg soil, while the best KCl treatment was 100 mg K_2O/kg soil. With KCl, average sugar beet yield was 454 g/pot and sugar yield was 68.9 g/pot. With K_2SO_4, these measurements were 456 and 67.0 g/pot, respectively.

Table 2. Effect of K rate and source on sugar beet yield and quality.

	K_2O rate, mg/kg soil	Root yield, g/pot	Increase over CK, %	Sugar content, %	Sugar yield, g/pot	Water content in the root, %
	50	425	7	16.0	68.2	73.4
	100	411	4	16.5	67.8	69.6
KCl	150	513	29*	15.7	80.6	72.0
	200	439	11	15.0	65.7	71.6
	500	481	21	12.9	62.1	71.4
	50	438	10	14.7	64.2	73.9
	100	409	3	13.7	56.0	73.6
K_2SO_4	150	471	19	16.1	75.9	73.4
	200	511	29*	14.0	71.3	73.0
	500	451	14	14.9	67.2	71.0
Ck (NP)		397	100	13.7	54.2	70.0

Note: $LSD_{0.05}$ = 9.7 (g/pot), $LSD_{0.01}$ = 46.2 (g/pot). *Significant at 5% level.

These results clearly show the positive effect K has on sugar beet growth and development. It increased beet yield, sugar content and sugar yield partly because of increased leaf area and chlorophyll content. With proper rates and placement (broadcast and incorporated) there was no significant difference between KCl and K_2SO_4 on sugar beet yield and quality on this soil with sufficient S. BCI

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